

Table A-3

## Some Properties of the Elements

Element	Symbol	Atomic Number (Z)	Atomic Mass*	Melting Point (°C)	Boiling Point (°C)	Density (g/cm <sup>3</sup> )	Atomic Radius (nm)	Standard Reduction Potential (V) (for elements in state indicated)	Enthalpy of Fusion (kJ/mol)	Specific Heat (J/g·°C)	Enthalpy of Vaporization (kJ/mol)	Abundance in Earth's Crust (%)	Major Oxidation States
Actinium	Ac	89	[227.0278]	817	2470	10.07	0.188	(3+)-2.6	10.5	—	293	trace	3+
Aluminum	Al	13	26.98154	660	2467	2.70	0.143	(3+)-1.66	10.5	0.900	8.3	8.3	3+
Americium	Am	95	[243.0614]	1170	2600	13.67	0.184	(3+)-2.38	10.0	239	—	—	3+, 4+
Antimony	Sb	51	121.75	631	1587	6.697	0.136	—	20.0	0.207	195	2 × 10 <sup>-4</sup>	3+, 5+
Argon	Ar	18	39.948	-189.37	-185.9	0.00178403	0.191	—	1.21	0.519	6.52	—	—
Arsenic	As	33	74.9216	816	615	5.778	0.125	—	93.7	0.331	128	1.8 × 10 <sup>-4</sup>	3+, 5+, 3-
			(3910 kPa)	337	(sublimes)	—	0.14	(1-)+0.3	11.9	—	(sublimes)	—	—
Astatine	At	85	[209.9871]	302	337	3.62	0.217	(2+)-2.90	7.8	0.179	45.2	0.039	2+
Barium	Ba	56	137.33	727	1850	14.78	—	(2+)-1.85	15	1.83	309	—	2+
Berkelium	Bk	97	[247.0703]	986	—	—	0.111	—	10.5	0.122	172	2 × 10 <sup>-5</sup>	3+, 5+
Beryllium	Be	4	9.01218	1287	2500	1.848	0.155	—	23.6	1.03	505	0.001	3+
Bismuth	Bi	83	208.9804	271	1564	9.808	0.083	—	10.6	0.349	30.0	5 × 10 <sup>-4</sup>	1-
Boron	B	5	10.811	2180	3650	2.35	0.111	(1-)+1.065	6.4	0.232	100	5 × 10 <sup>-5</sup>	2+
Bromine	Br	35	79.904	-7.25	59.5	3.19	0.149	(2+)-0.4026	8.6	0.652	155	4.66	2+
Cadmium	Cd	48	112.41	321	765	8.65	0.197	(2+)-2.76	—	—	—	—	—
Calcium	Ca	20	40.078	839	1494	1.55	0.197	—	105	0.716	326	0.018	4+
Californium	Cf	98	[251.0796]	900	—	14	0.077	—	5.2	0.194	398	0.0066	3+, 4+
Carbon	C	6	12.011	4100	4827	3.614	0.183	(3+)-2.335	2.09	0.238	67	1 × 10 <sup>-4</sup>	1+
Cerium	Ce	58	140.12	804	3470	6.773	0.265	(1+)-2.923	6.41	0.477	20.4	0.0126	1-
Cesium	Cs	55	132.9054	28.5	705	1.90	0.099	(2+)-0.557	21	0.448	342	0.0122	2+, 3+, 6+
Chlorine	Cl	17	35.453	-101.00	-34.0	0.00298	0.125	(2+)-0.28	16.3	0.446	382	0.0029	2+, 3+
Chromium	Cr	24	51.9961	1900	2690	7.14	0.125	(1+)+0.522	13.0	0.386	307	0.0068	1+, 2+
Cobalt	Co	27	58.9332	1495	3100	8.90	0.128	(2+)+0.3402	—	—	—	—	3+
Copper	Cu	29	63.546	1083	2567	8.95	—	(3+)-2.35	17.2	0.173	280	3 × 10 <sup>-4</sup>	3+
Curium	Cm	96	[247.0703]	1340	—	13.51	—	(3+)-2.30	17.2	0.168	280	2.4 × 10 <sup>-4</sup>	3+
Dysprosium	Dy	66	162.50	1407	2600	8.559	0.177	(3+)-2.41	10.5	0.156	176	1.2 × 10 <sup>-4</sup>	2+, 3+
Einsteinium	Es	99	[252.0828]	860	—	—	0.176	—	0.51	0.824	6.54	0.0544	1-
Erbium	Er	68	167.26	1497	2900	9.045	0.204	(3+)-2.4	15.5	0.232	301	5.3 × 10 <sup>-4</sup>	1+
Europium	Eu	63	151.96	826	1939	5.245	0.072	(3+)-0.560	36.8	0.374	270	7 × 10 <sup>-4</sup>	3+
Fermium	Fm	100	[257.0951]	—	—	—	0.123	(2+)+0.23	—	0.322	328	1.5 × 10 <sup>-4</sup>	2+, 4+
Fluorine	F	9	18.998403	-218.6	-188.14	0.001580	0.072	—	—	—	—	—	—
Francium	Fr	87	[223.0197]	27	677	—	0.27	—	—	—	—	—	—
Gadolinium	Gd	64	157.25	1312	3000	7.886	0.180	—	—	—	—	—	—
Gallium	Ga	31	69.723	29.78	2403	5.904	0.122	—	—	—	—	—	—
Germanium	Ge	32	72.59	945	2850	5.323	0.123	—	—	—	—	—	—

\* [ ] indicates mass of longest-lived isotope

Element	Symbol	Atomic Number (Z)	Atomic Mass*	Melting Point (°C)	Boiling Point (°C)	Density (g/cm <sup>3</sup> )	Atomic Radius (nm)	First Ionization Energy (kJ/mol)	Standard Reduction Potential (V) (for elements state indicated)	Enthalpy of Fusion (kJ/mol)	Specific Heat (J/g·°C)	Enthalpy of Vaporization (kJ/mol)	Abundance in Earth's Crust (%)	Oxidation States
Gold	Au	79	196.9665	1084	2808	19.32	0.144	890	(3+)+1.42	12.8	0.128	343	5 × 10 <sup>-7</sup>	1+, 3+
Hafnium	Hf	72	178.49	2222	4450	13.3	0.156	675	(4+)-1.70	25.1	0.136	571	5 × 10 <sup>-4</sup>	4+
Helium	He	2	4.002602	-272.2	-268.9	0.00017847	0.122	2372	—	0.0182	5.19	0.08	—	—
Holmium	Ho	67	164.9304	1461	2600	8.78	0.177	581	(3+)-2.32	17.2	0.165	280	1.2 × 10 <sup>-4</sup>	3+
Hydrogen	H	1	1.00794	-259.19	-252.76	0.00008987	0.053	1312	(1+) 0.0000	0.117	14.3	0.904	0.152	1+
Indium	In	49	114.82	157	2080	7.31	0.163	558	(3+)-0.338	3.26	0.235	232	1 × 10 <sup>-5</sup>	1+, 3+
Iodine	I	53	126.9045	113.6	185.2	4.94	0.128	1008	(1-)+0.535	15.5	0.285	41.0	5 × 10 <sup>-5</sup>	1-
Iridium	Ir	77	192.22	2443	4550	22.61	0.136	878	(3+)+1.15	26.4	0.130	612	1 × 10 <sup>-7</sup>	2+, 3+, 4+
Iron	Fe	26	55.847	1535	2750	7.874	0.124	759	(2+)-0.409	13.8	0.448	340	6.2	2+, 3+
Krypton	Kr	36	83.80	-157.20	-153.4	0.0037493	0.198	1351	—	1.63	0.247	9.05	1.4 × 10 <sup>-8</sup>	2+, 3+
Lanthanum	La	57	138.9055	920	3420	6.17	0.188	538	(3+)-2.37	8.5	0.199	402	0.0035	3+
Lawrencium	Lr	103	[260.1054]	—	—	—	—	—	—	—	—	—	—	—
Lead	Pb	82	207.2	327.5	1751	11.342	0.175	716	(2+)-0.126	4.81	0.138	178	0.002	2+, 4+
Lithium	Li	3	6.941	180.54	1347	0.534	0.152	520	(1+)-3.045	2.93	3.48	148	0.005	1+
Lutetium	Lu	71	174.967	1652	3327	9.840	0.173	524	(3+)-2.25	19.2	0.137	414	5 × 10 <sup>-5</sup>	3+
Magnesium	Mg	12	24.305	649	1105	1.738	0.160	738	(2+)-2.375	8.9	1.01	127	2.76	2+
Manganese	Mn	25	54.9380	1244	2060	7.43	0.124	717	(2+)-1.029	13.4	0.480	221	0.106	2+, 4+, 6+, 7+
Mendelevium	Md	101	[258.0936]	—	—	—	—	—	—	—	—	—	—	—
Mercury	Hg	80	200.59	-38.84	356.58	13.534	0.160	1007	(2+)+0.851	2.30	0.139	59.1	5 × 10 <sup>-6</sup>	1+, 2+
Molybdenum	Mo	42	95.94	1620	4650	10.28	0.136	685	(3+)-0.2	27.6	0.248	594	1.5 × 10 <sup>-4</sup>	2+, 3+, 4+, 5+, 6+
Neodymium	Nd	60	144.24	1024	3027	7.003	0.182	530	(3+)-2.246	7.13	0.201	289	0.0040	3+
Neon	Ne	10	20.179	-248.61	-246.06	0.00089994	0.160	2081	—	0.324	1.03	1.74	5 × 10 <sup>-7</sup>	—
Neptunium	Np	93	237.0482	640	5235	20.45	0.131	—	(3+)-1.86	9.46	0.124	336	—	3+, 4+, 6+
Nickel	Ni	28	58.69	1455	2920	8.908	0.125	737	(2+)-0.23	17.2	0.443	375	0.0099	2+, 3+
Niobium	Nb	41	92.9064	2468	4758	8.57	0.143	664	(3+)-1.1	26.8	0.266	680	0.0020	3+, 4+, 5+
Nitrogen	N	7	14.0067	-210.0	-195.8	0.0012500	0.070	1402	—	0.721	1.04	5.58	0.0019	3-
Nobelium	No	102	[259.1009]	—	—	—	—	—	—	—	—	—	—	—
Osmium	Os	76	190.2	3045	5025	22.57	0.134	839	(2+)+0.85	31.7	0.130	738	—	2+, 3+, 4+, 6+, 8+
Oxygen	O	8	15.9994	-218.8	-182.96	0.001429	0.066	1314	—	0.445	0.916	6.81	45.5	2-
Palladium	Pd	46	106.42	1552	2940	11.99	0.138	805	(2+)+0.83	17.6	0.245	362	—	2+, 3+, 4+
Phosphorus	P	15	30.97376	44.1	281	1.823	0.115	1012	—	2.51	0.724	49.8	0.112	3+, 5+, 3-
Platinum	Pt	78	195.08	1769	4170	21.410	0.138	868	(2+)+1.2	19.7	0.134	469	1 × 10 <sup>-6</sup>	2+, 4+
Plutonium	Pu	94	[244.0642]	640	3230	19.86	0.157	560	(3+)-2.02	2.80	0.137	344	—	3+, 4+, 6+
Polonium	Po	84	[208.9824]	254	962	9.32	0.167	812	(2+)+0.60	12.6	0.126	103	—	2+, 4+
Potassium	K	19	39.0983	63.2	766	0.856	0.227	419	(1+)-2.924	2.39	0.748	79.0	trace	1+
Praseodymium	Pr	59	140.9077	935	3020	6.475	0.183	523	(3+)-2.47	11.3	0.197	331	1.84	3+, 4+
Promethium	Pm	61	[144.9128]	1168	2460	7.22	0.181	536	(3+)-2.42	12.6	0.185	293	8.0 × 10 <sup>-4</sup>	3+

\*[ ] indicates mass of longest-lived isotope



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Protactinium	Pa	91	231.0359	1552	4227	15.37	0.161	—	16.7	0.121	481	trace	4+, 5+
Radium	Ra	88	226.0254	700	1140	5.5	0.220	(2+)-2.92	8.37	0.120	146	1 × 10 <sup>-11</sup>	2+
Radon	Rn	86	[222.176]	-71	-62	0.00973	0.22	—	3.25	0.0937	18.1	4 × 10 <sup>-17</sup>	
Rhenium	Re	75	186.207	3180	5650	21.02	0.137	—	34	0.138	704	1 × 10 <sup>-7</sup>	3+, 4+, 5+, 6+, 7+
Rhodium	Rh	45	102.9055	1960	3760	12.39	0.135	(3+)+0.8	21.6	0.245	494	1 × 10 <sup>-7</sup>	2+, 3+, 4+
Rubidium	Rb	37	85.4678	39	688	1.532	0.248	(1+)-2.924	2.20	0.359	76	0.0078	1+
Ruthenium	Ru	44	101.07	2282	4050	12.41	0.133	—	25.5	0.238	568	4 × 10 <sup>-8</sup>	3+, 4+, 5+, 8+
Samarium	Sm	62	150.36	1072	1800	7.536	0.180	(3+)-2.41	8.9	0.188	165	6 × 10 <sup>-4</sup>	2+, 3+
Scandium	Sc	21	44.95591	1539	2748	2.989	0.16	(3+)-2.08	15.8	0.524	333	0.0022	3+
Selenium	Se	34	78.96	217	685	4.39	0.114	(2+)-0.78	5.10	0.272	59.7	9 × 10 <sup>-6</sup>	2-, 4+, 6+
Silicon	Si	14	28.0855	1420	3280	2.336	0.117	—	50.6	0.705	383	27.2	4+, 4-
Silver	Ag	47	107.86821	961	2155	10.49	0.144	(1+)+0.7996	11.1	0.236	258	1 × 10 <sup>-5</sup>	1+
Sodium	Na	11	22.98977	97.81	881.4	0.968	0.192	(1+)-2.7109	2.64	1.23	99	2.27	1+
Strontium	Sr	38	87.62	768	1381	2.63	0.215	(2+)-2.89	8.2	0.296	158	0.0384	2+
Sulfur	S	16	32.066	112.8	444.7	2.07	0.104	(2-)-0.508	1.23	0.736	10.5	0.034	2-, 4+, 6+
Tantalum	Ta	73	180.9479	2980	5534	16.65	0.143	—	24.7	0.140	758	2 × 10 <sup>-4</sup>	3+, 4+, 5+
Technetium	Tc	43	97.9072	2200	4567	11.50	0.136	—	23.0	0.243	585	—	4+, 5+, 6+, 7+
Tellurium	Te	52	127.60	452	989.8	6.25	0.143	(2-)-0.92	13.5	0.201	49.8	2 × 10 <sup>-7</sup>	2-, 4+, 6+
Terbium	Tb	65	158.9254	1356	2800	8.253	0.178	(3+)-2.39	16.3	0.182	293	1 × 10 <sup>-4</sup>	3+
Thallium	Tl	81	204.383	303.5	1457	11.85	0.170	(1+)-0.3363	4.31	0.129	166	7 × 10 <sup>-5</sup>	1+, 3+
Thorium	Th	90	232.0381	1750	4850	11.78	0.180	(4+)-1.90	16.11	0.123	514	0.0015	4+
Thulium	Tm	69	168.9342	1545	1727	9.318	0.175	(3+)-2.28	18.4	0.160	247	4.6 × 10 <sup>-5</sup>	3+
Tin	Sn	50	118.710	232	2623	7.265	0.141	(2+)-0.136	7.07	0.220	296	6 × 10 <sup>-4</sup>	2+, 4+
Titanium	Ti	22	47.88	1667	3285	4.50	0.145	(2+)-1.63	18.8	0.520	425	0.632	2+, 3+, 4+
Tungsten	W	74	183.85	3410	5500	19.3	0.137	—	35.2	0.134	824	1.5 × 10 <sup>-4</sup>	2+, 4+, 5+, 6+
Unilennium	Une	109	[266]	—	—	—	—	—	—	—	—	—	—
Unihexium	Unh	106	[263]	—	—	—	—	—	—	—	—	—	—
Uniloctium	Uno	108	[265]	—	—	—	—	—	—	—	—	—	—
Unilpentium	Unp	105	[260]	—	—	—	—	—	—	—	—	—	—
Unilquadium	Unq	104	[257]	—	—	—	—	—	—	—	—	—	—
Unilseptium	Uns	107	[258]	—	—	—	—	—	—	—	—	—	—
Uranium	U	92	238.0289	1130	3930	19.05	0.139	(3+)-1.80	12.6	0.116	417	2 × 10 <sup>-5</sup>	3+, 4+, 5+, 6+
Vanadium	V	23	50.9415	1915	3350	6.11	0.132	(2+)-1.18	17.5	0.484	459.7	0.0136	2+, 3+, 4+, 5+
Xenon	Xe	54	131.29	-111.80	-108.1	0.0058971	0.218	—	3.10	0.158	12.7	—	—
Ytterbium	Yb	70	173.04	824	1427	6.973	0.194	(3+)-2.27	3.35	0.132	159	3 × 10 <sup>-4</sup>	2+, 3+
Yttrium	Y	39	88.9059	1530	3264	4.469	0.181	(3+)-2.37	11.5	0.291	367	0.0034	3+
Zinc	Zn	30	65.39	419.5	907	7.14	0.133	(2+)-0.763	7.28	0.386	114	0.0076	2+, 3+
Zirconium	Zr	40	91.224	1857	4200	6.506	0.160	(4+)-1.53	19.2	0.278	567	0.0162	2+, 3+

\* [ ] indicates mass of longest-lived isotope